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RESEARCH ARTICLE

Multimodality Approach to Sino-Nasal and Cerebral Mucormycosis and Related Intracranial Complications

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Abstract

Mucormycosis is a serious fungal infection that frequently affects the paranasal sinuses and can spread to the orbit and brain, especially in individuals with weakened immune systems. This case series includes 70 patients suspected of having mucormycosis, who were assessed using a comprehensive radiologic strategy involving computed tomography and magnetic resonance imaging. The results showed maxillary sinus involvement in 30 patients, involvement of the ethmoid and sphenoid sinuses in 20 patients each and frontal sinus involvement in 3 patients. Orbital involvement, with indications of orbital apex syndrome, was observed in 14 patients. Skull base involvement was found in 2 patients. Six patients exhibited intracranial complications such as infarcts, abscesses and enhancement of the meninges. Involvement of the infratemporal and pterygopalatine fossae was recorded in 10 patients. All patients received surgical treatment, which included functional endoscopic sinus surgery and maxillectomy. The study highlights the importance of early multimodal imaging for accurate diagnosis, effective treatment planning and determining prognosis.

Key Words: *Mucormycosis; Paranasal sinuses; Cerebral infection; Orbital apex Syndrome; CT; MRI; FESS; Skull base involvement; Intracranial complications*

Introduction

Coronaviruses, belonging to the coronaviridae family, represent a major group of viruses that have surfaced as significant pathogens impacting human populations in the 21st century. The initial large outbreak linked to a coronavirus was the Severe Acute Respiratory Syndrome (SARS) epidemic, which began in February 2003 in China and quickly spread to various countries [1]. This was succeeded by the emergence of the Middle East Respiratory Syndrome (MERS) in 2012, which was reported in several regions of the Middle East, Africa and South Asia [2]. Although these outbreaks had substantial health repercussions, their transmission was relatively limited compared to what unfolded in late 2019 [3].

The COVID-19 pandemic, triggered by a new beta coronavirus (originally labeled 2019-nCoV and later renamed SARS-CoV-2), was first recognized in Wuhan, China, in December 2019, following reports of a puzzling pneumonia of unidentified origin. The virus

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swiftly disseminated worldwide, leading to widespread illness, fatalities and immense strain on healthcare systems. COVID-19 primarily impacts the respiratory system but has also been linked to a diverse array of systemic complications and secondary infections.

One of the most alarming of these complications is mucormycosis, a rare but highly aggressive fungal infection known for its angioinvasive properties, formerly referred to as zygomycosis. This infection is mainly caused by molds from the order Mucorales, with Rhizopus oryzae being the predominant pathogen, accounting for around 60% of documented cases. Mucormycosis typically afflicts immunocompromised individuals, including those with poorly managed diabetes, hematologic cancers and patients receiving corticosteroids or immunosuppressive therapy.

The increase in mucormycosis cases during the COVID-19 pandemic, especially in India, has raised significant concerns. Several factors contribute to the increased susceptibility in individuals recovering from COVID-19:

- Hypoxia resulting from lung complications.
- Elevated blood sugar levels due to pre-existing diabetes or corticosteroid-induced metabolic disruptions.
- Acidosis, particularly observed in Diabetic Ketoacidosis (DKA).
- Extended use of broad-spectrum antibiotics and corticosteroids.
- Weakened immune response due to SARS-CoV-2 infection and its treatment.
- Prolonged hospitalizations, mechanical ventilation use and comorbid conditions such as hematologic cancers or chronic kidney disease [4].

Clinically, mucormycosis often starts with vague sinonasal symptoms like nasal blockage, facial discomfort, headaches, nosebleeds and fever. As the disease advances, it can lead to necrotizing vasculitis, causing rapid spread into the orbits, facial soft tissues, palate and cranial cavity, often utilizing natural anatomical passages in the skull base [5]. Severe complications seen in later stages include orbital cellulitis, cranial nerve palsies, cavernous sinus thrombosis and brain infarctions.

The influence of iron metabolism on the pathogenesis of mucormycosis has also garnered attention. It is hypothesized that iron overload or chelation therapy using agents like deferoxamine may promote fungal proliferation by enhancing iron's bioavailability to the pathogen. Nevertheless, the precise mechanisms are still being studied.

In light of the concerning rise in mucormycosis incidences, particularly among post-COVID-19 patients, early detection and prompt treatment are essential. Imaging methods such as CT and MRI are crucial for assessing disease extent, identifying complications and informing surgical planning. This study seeks to examine the radiological features, patterns of spread and clinical implications of post-COVID mucormycosis, aiming to facilitate early identification and management of this life-threatening infection.

Stages of the disease

Stage-I: Infection affecting the nasal mucosa and sinuses.

Stage-II: Involvement of the orbit (known as orbital apex syndrome).

Stage-III: Involvement of the brain with intracranial spread via the ophthalmic artery, superior orbital fissure and cribriform plate [6].

Diagnosis can be established through direct microscopy and histopathological analysis, while the disease's severity and intracranial

damage can be assessed using imaging studies in confirmed cases [6]. In this study, suspected cases of mucormycosis underwent various radiological examinations, including CT scans and MRIs. A CT scan of the paranasal sinuses and brain was performed without contrast to specifically examine the bony erosions, destruction of the paranasal sinuses, bony walls of the orbits and any intracranial extension.

Materials and Methods

A prospective observational study was carried out in the Emergency Department of Medicover Hospitals over four months, from March to June 2021. This study was initiated in response to the increasing cases of mucormycosis following COVID-19 infection, with the aim of assessing its clinical and radiological characteristics, complications and treatment outcomes.

Study population

Seventy patients presenting with a clinical suspicion of mucormycosis in the post-COVID recovery phase were included. All patients had previously tested positive for SARS-CoV-2 through RT-PCR or antigen testing and subsequently showed symptoms indicative of Rhino-Orbito-Cerebral Mucormycosis (ROCM), such as facial swelling, nasal discharge, headache, orbital pain or visual disturbances.

Inclusion criteria

- Individuals aged 18 years and older.
- Confirmed history of COVID-19 infection (within the last 3 months).
- Clinical suspicion or diagnosis of mucormycosis based on evaluations by ENT or ophthalmology specialists.
- Patients who underwent radiological assessments, including Computed Tomography (CT) and/or Magneti Resonance Imaging (MRI).

Exclusion criteria

- Individuals with no history of COVID-19 infection.
- Known cases of HIV/AIDS or other forms of significant immunosuppression unrelated to COVID-19.
- Pregnant individuals.
- Patients who were unwilling or unable to participate in imaging studies.

Imaging evaluation

All patients underwent contrast-enhanced CT and/or MRI scans analyzed by radiologists specialized in neuroimaging and head and neck conditions. The imaging techniques were employed to evaluate:

- Involvement of paranasal sinuses.
- Extension to the orbital and intracranial regions.
- Erosion of bone and infiltration of the skull base.
- Vascular issues and soft tissue involvement.

MRI protocols included T1-weighted, T2-weighted, fat-saturated post-contrast, Diffusion-Weighted Imaging (DWI) and gradient echo sequences. CT scans were primarily utilized to assess bony involvement and identify hyperdense fungal components located within the sinuses.

Data collection and analysis

Demographic information, clinical presentations, imaging findings, surgical procedures and outcomes were documented for all patients. The data were systematically organized and analyzed to identify disease spread patterns, radiological features and their correlation with clinical outcomes.

Objectives

- The main objectives of the study were: To assess the complications and extent of mucormycosis in post-COVID patients using radiological imaging.
- To identify early radiological markers indicative of disease progression and facilitate timely surgical interventions.
- To evaluate the relationship between imaging findings and clinical prognosis.
- Ethical approval for this study was secured from the institutional review board and informed consent was obtained from all patients or their legal guardians participating in the study.

Imaging equipment used:
MRI scans were performed using a 1.5 Tesla Philips Multiva system.

CT scans were acquired using a 128-slice Philips Ingenuity scanner.

Results

In our research cohort of 70 patients with clinically suspected mucormycosis, imaging techniques mainly contrast-enhanced Computed Tomography (CT) and Magnetic Mesonance Imaging (MRI) were employed to evaluate the disease's prevalence and inform clinical strategies. The imaging results displayed a distinctive pattern of disease progression, which assisted in both diagnosis and surgical planning.

Paranasal sinus involvement

Involvement of the paranasal sinuses was consistently observed and served as a key indicator of the disease's origin. The breakdown was as follows (Table 1)

TABLE 1
Distribution of anatomical involvement in patients with mucormycosis.

Sr no	Regions involved	Number of cases
1	Maxillary sinuses	30
2	Ethmoid sinuses	20
3	Sphenoid sinuses	20
4	Frontal sinuses	2
5	Orbital involvement	14
6	Skull base involvement	2
7	Infratemporal and pterygopalatine fossa	10
8	Skull base involvement with destruction of basi-sphenoid and greater wing of sphenoid	5

- **Maxillary sinuses:** Affected in 30 cases (42.8%), making it the most commonly involved sinus.
- **Ethmoid sinuses:** Involved in 20 cases (28.5%), often accompanied by erosion of the orbital wall.
- **Sphenoid sinuses:** Also affected in 20 cases (28.5%), raising concerns about possible extension to the skull base or cavernous sinus.
- **Frontal sinuses:** Relatively infrequent, with involvement noted in only 3 cases (4.3%).

Orbital and skull base involvement

Orbital invasion was documented in 14 cases

(20%), with imaging revealing signs such as breach of the lamina papyracea, proptosis, intraorbital soft tissue infiltration and in some cases, optic nerve involvement. Among these, a few patients displayed characteristics consistent with orbital apex syndrome, which involves vision loss and cranial nerve dysfunction. Skull base invasion was seen in 2 cases (2.8%), appearing as bony destruction in the basi-sphenoid area and surrounding structures an alarming finding because of its closeness to vital neurovascular components.

Intracranial complications

The infections spread into the intracranial space was recognized in 6 cases (8.5%), manifesting as:

- Meningeal enhancement on contrast-enhanced MRI,
- Acute cerebral infarctions, likely caused by vascular invasion and thrombosis,
- Parenchymal abscesses, indicating direct intracerebral extension.

Extension to deep facial spaces

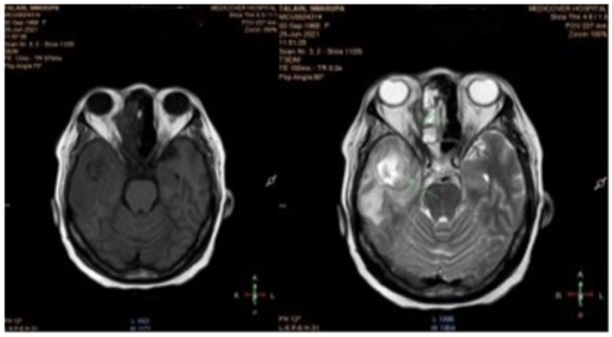
Imaging additionally revealed disease progression into the infratemporal and pterygopalatine fossae in 10 cases (14.2%), suggesting a more advanced and aggressive type of mucormycosis. These extensions frequently corresponded with erosion of the posterior sinus walls and involvement of neighboring fat planes and muscles.

Surgical management

Among the 70 patients, 61 cases (87.1%) underwent surgical treatment, customized according to the extent of disease involvement:

- Functional Endoscopic Sinus Surgery (FESS) was the most frequently performed procedure, facilitating minimally invasive debridement of necrotic tissues within the paranasal sinuses.
- Maxillectomy was required in 7 cases (11.4%), primarily due to extensive bony involvement of the maxilla and surrounding structures.
- Orbital exenteration was executed in 3 cases (4.9%), where irreversible damage to the orbit or vision loss was evident, particularly with confirmed optic nerve involvement and orbital apex syndrome.

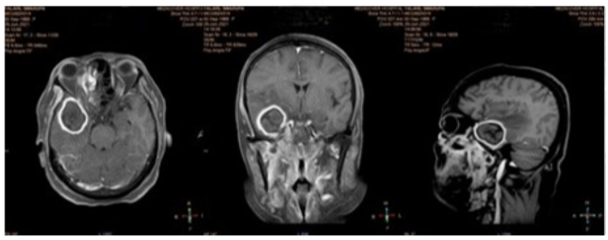
MRI plays a crucial role in assessing orbital extension, particularly involving the rectus muscles and in identifying optic neuritis. It is effective in revealing intracranial extension to mainly the temporal or frontal lobes accompanied by fungal abscess formation (Figures 1 and 2).



[1a] [1b]

A 57-year-old female underwent MRI imaging of the orbits, sinuses and brain.

Figure 1) *Sino nasal and orbital mucormycosis. Figure 1a and 1b with T1/T2 sequences show lesions at right temporal lobe with surrounding edema.*



[2a] [2b] [2c]

A 57-year-old female underwent MRI imaging of the orbits, sinuses and brain.

Figure 2) *Figures 2a, 2b and 2c: Post contrast study shows large ring enhancing lesion at right temporal lobe suggest abscess.*

CT characteristics of mucormycosis

Computed Tomography (CT) imaging has been essential for the prompt identification of mucormycosis, especially in analyzing bony structures and contents of the sinuses. A distinctive CT feature noted was a concentric lamellated pattern within the paranasal sinuses. This pattern was marked by alternating regions of hyperdensity and hypodensity, strongly indicating a fungal cause.

The hyperdense regions were linked to dense inspissated secretions, necrotic material and the presence of fungal hyphae. Hypodense areas represented underlying mucosal swelling, cystic changes and regions of granulation tissue formation. This pattern of mixed densities was highly suggestive of invasive fungal sinusitis and helped differentiate mucormycosis from other sinusitis types.

MRI characteristics of sinus secretions

Magnetic Resonance Imaging (MRI) offered superior contrast for soft tissues and was particularly valuable in assessing involvement of the skull base and intracranial structures. A significant characteristic of fungal sinus secretions in MRI is their elevated protein content, which can misleadingly imitate aerated sinuses by appearing hypointense in both T1- and T2-weighted images. This effect can obscure disease detection on standard sequences if not interpreted cautiously.

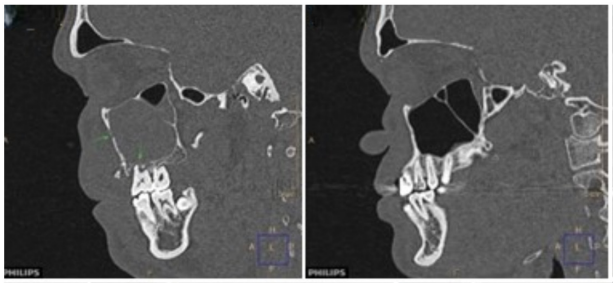
MRI was particularly beneficial for evaluating

Skull base invasion, where normal hyperintense fatty marrow (observed on T1-weighted sequences) is replaced by hypointense fungal infiltrates, indicating early bone marrow involvement. Structures like the basisphenoid and the petrous portion of the temporal bone, which normally show hyperintensity due to fat content, could be readily assessed for signal loss, bone erosion, or mass effects indicative of fungal infiltration.

CT features of sino-nasal mucormycosis

A thorough CT evaluation of the sinonasal cavity offered critical surgical details:

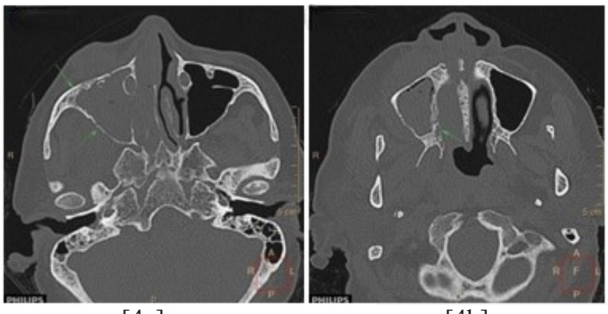
- Bony erosions were evident in the medial and posterior aspects of the maxillary sinuses, the medial orbital wall and the ethmoid roof, often displaying subtle yet diagnostic features (Figures 3-6).



[3a] [3b]

A 61-year-old male had a CT scan of the paranasal sinuses revealing mucormycosis in the right maxillary sinus.

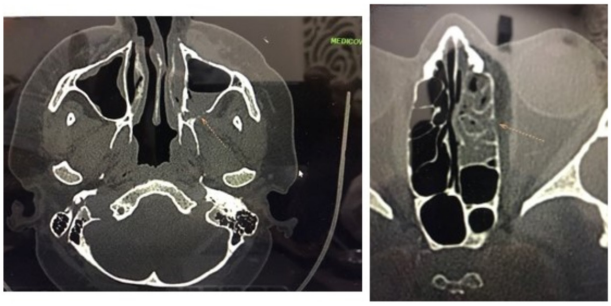
Figure 3) *Figures 3a and 3b show erosions at anterior wall of right maxillary sinus.*



[4a] [4b]

A 61-year-old male had a CT scan of the paranasal sinuses revealing mucormycosis in the right maxillary sinus.

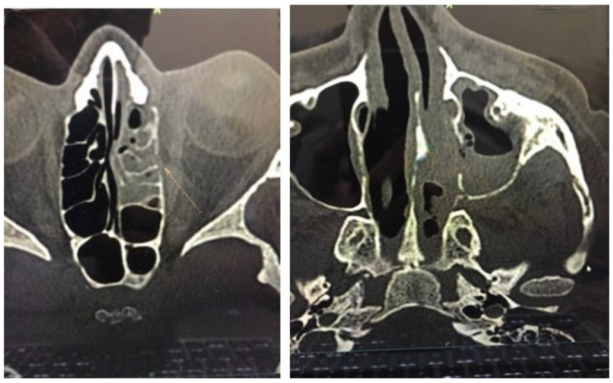
Figure 4) *Figures 4a and 4b show subtle bony erosions of maxillary sinuses.*



[5a] [5b]

A 58-year-old male underwent a CT scan of the paranasal sinuses, revealing mucormycosis in the left maxillary sinus and orbit.

Figure 5) *Figures 5a and 5b: Bony erosions at medial wall of left orbit and involving lamina papyracea, bony erosions at posteromedial walls of left maxillary sinus.*

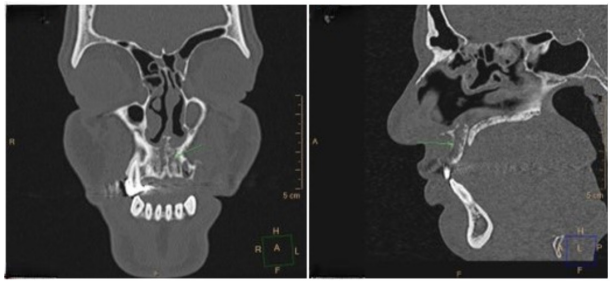


[6a] [6b]

Another 58-year-old male had a CT scan of the paranasal sinuses indicating mucormycosis in the left maxillary sinus and orbit.

Figure 6) *Figures 6a and 6b: Erosions at lamina papyracea at medial wall left orbit, erosions of medial and posterior walls of left maxillary sinus.*

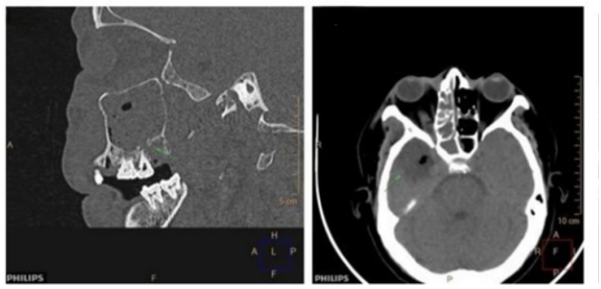
- Erosion of the cribriform plate and ethmoid roof raised concerns for potential intracranial extension, necessitating immediate attention and frequently altering the surgical strategy (Figures 7 and 8).



[7a] [7b]

A 59-year-old male had a CT scan of the paranasal sinuses and orbits showing mucormycosis affecting the hard palate.

Figure 7) *Figures 7a and 7b: Significant bone erosions at hard palate.*

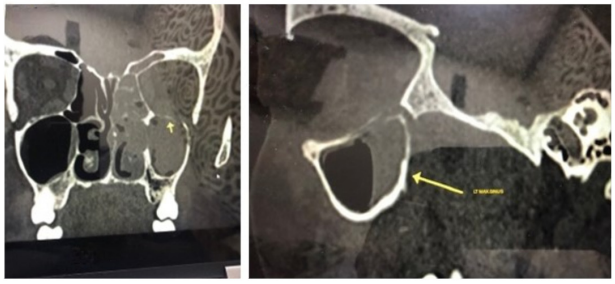


[8a] [8b]

A 65-year-old male underwent a CT scan of the paranasal sinuses, showing mucormycosis in the right maxillary sinus.

Figure 8) *Figures 8a shows bony erosions of maxillary sinus and involving the alveolar process of maxilla, 8b reveal evolving abscess at right temporal lobe.*

- Erosions of the orbital floor extending toward the inferior rectus muscle were clearly outlined, corresponding with clinical signs like proptosis and ophthalmoplegia (Figure 9).

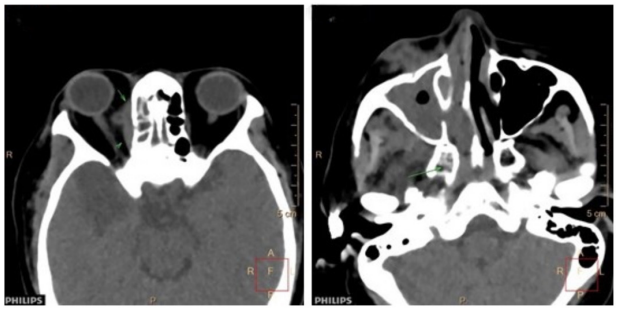


[9a] [9b]

53-year-old female received a CT scan of the orbits and paranasal sinuses, indicating mucormycosis in the left orbit.

Figure 9) *Figures 9a and 9b: Coronal and sagittal images show bone erosions at floor of left orbit.*

- CT also effectively demonstrated the infection's spread into deep facial spaces, particularly the infratemporal and pterygopalatine fossae, along with erosion of the pterygoid plates (Figure 10).



[10a] [10b]

A 59-year-old male had a CT scan of the paranasal sinuses.

Figure 10) *Figures 10a and 10b: Sino nasal mucormycosis involving right maxillary sinus, nasal cavity and right orbit with soft tissue lesion anterior to the maxillary sinus.*

- Involvement of the hard palate and alveolar processes of the maxilla was observable in multiple cases, which is essential for planning maxillectomy.
- Hyperdense soft tissue within the sinus cavities, consistent with thick fungal elements and secretions, was another important diagnostic indicator, especially in non-contrast scans.

In summary, a combination of mucosal thickening, bony erosions and intraluminal hyperdense material was highly indicative of invasive fungal sinusitis, particularly mucormycosis.

MRI sequences useful in diagnosis

The following MRI sequences were determined to be most effective for assessing disease extent:

- **T1-weighted images:** Useful for identifying the loss of normal fat planes and changes in bone marrow signals at the skull base.
- **T2-weighted images:** Offered contrast between edematous and necrotic tissues, though they might underrepresent fungal masses due to their low signals.
- **Fat-saturated T2-weighted images:** Enhanced sensitivity for detecting orbital and perineural extension by suppressing background fat signals.
- **Post-contrast T1-weighted images with fat saturation:** Essential in defining non-enhancing necrotic tissues (known as the black turbinate sign), vascular invasion and abscess formation.

Fat suppression sequences

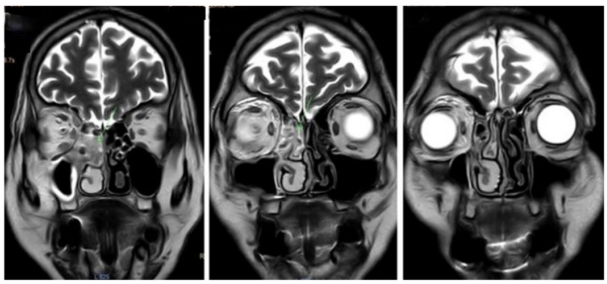
Fat-suppressed MRI sequences were crucial in diminishing high-intensity signals from the bony and orbital fat, thus revealing subtle pathological changes in the surrounding soft tissues. These sequences permitted a clear visualization of disease spread through the lamina papyracea into the orbit, with infiltration into extraocular muscles, especially the medial and inferior rectus. The visibility of perineural and periorbital spread was enhanced with fat-suppressed post-contrast imaging. Notably, invasion of the skull base, particularly into the clivus and sphenoid bone, was more effectively visualized due to the contrast between hyperintense normal marrow and hypointense areas of fungal infiltration.

Pre-contrast MRI sequences

Diffusion-Weighted Imaging (DWI) : The DWI sequence was beneficial in identifying acute inflammation, with restricted diffusion noted in areas with mucosal edema, especially in the ethmoid and sphenoid sinuses. In certain instances, early ischemic infarcts caused by fungal vascular invasion were also detectable on DWI.

T1-Weighted Imaging (T1WI): T1WI offered excellent differentiation for assessing fatty marrow at the skull base, including the clivus, basisphenoid and petrous apex. A loss of T1 hyperintensity in these regions, along with cortical disruption, strongly indicated fungal infiltration and marrow replacement.

T2-Weighted Imaging (T2WI): T2WI sequences displayed hypointense signals in areas containing dense fungal organisms, necrosis, or hemorrhagic tissue. A distinctive finding was the “black turbinate sign” a diffusely T2 hypointense nasal turbinate regarded as a hallmark of mucormycosis (Figure 11). This sign signifies necrosis and the non-viability of the turbinate tissue.



[11a] [11b] [11c]

A 62-year-old male underwent MRI imaging of the orbits and paranasal sinuses.

Figure 11) *Figures 11a, 11b and 11c: Sino nasal mucormycosis involving right nasal cavity, nasal turbinates with obstruction to right maxillary ostium.*

- T2 Gradient Echo (T2 GRE) / Susceptibility-Weighted Imaging (SWI).
- T2 GRE/SWI sequences were utilized to

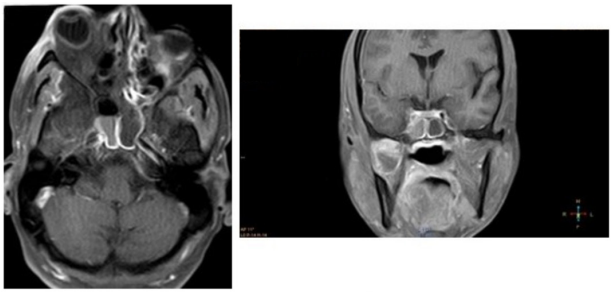
evaluate bony erosions, particularly in fragile bones like the cribriform plate and medial orbital wall, which may not be clearly visible on conventional imaging.

These sequences also assisted in identifying microhemorrhages or hemosiderin deposits, which could suggest angioinvasion or infarcts.

Post-contrast MRI imaging

Post-contrast T1-weighted fat-saturated sequences were crucial for defining:

- Non-enhancing necrotic tissue within the sinuses and orbit.
- Pseudo-pneumatized sphenoid sinus with mucocele (Figure 12).

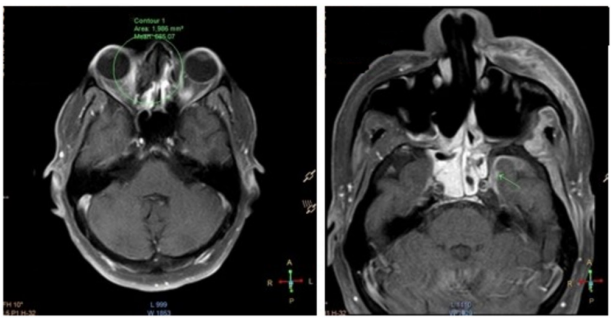


[12a] [12b]

A 67-year-old female had an MRI of the orbits and paranasal sinuses.

Figure 12) *Figures 12a and 12b: Sino nasal and orbital mucormycosis with involvement of sphenoid sinus and right nasal cavity, orbit. Retro-orbital inflammation with proptosis. Pseudo-pneumatized sphenoid sinus suggests mucormycosis.*

- Continuous extension into the orbits and intracranial compartment (Figures 13).
- Intracranial involvement through the cribriform plate, primarily from the ethmoid sinuses (commonly affected sites).
- Vascular complications, including blockage of the cavernous segment of the internal carotid artery and thrombosis of the superior ophthalmic vein.

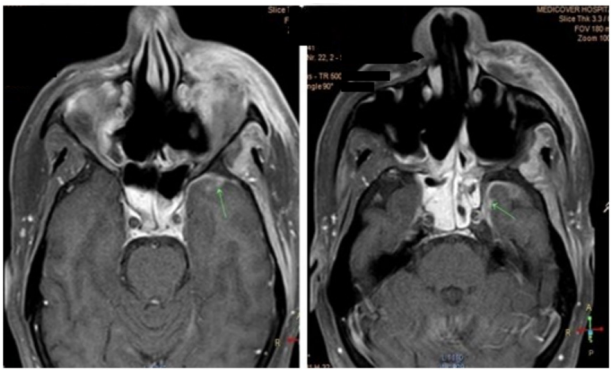


[13a] [13b]

A 61-year-old female underwent an MRI of the orbits and paranasal sinuses.

Figure 13) *Figure 13a show Mucormycosis of right anterior ethmoid sinus with extension to right orbit. Figure 13b show Sphenoid sinus mucormycosis and intracranial extension to left temporal lobe.*

Enhancement of the meninges, brain parenchymal abscesses and focal infarctions were notable characteristics in patients exhibiting intracranial spread (Figure 14).



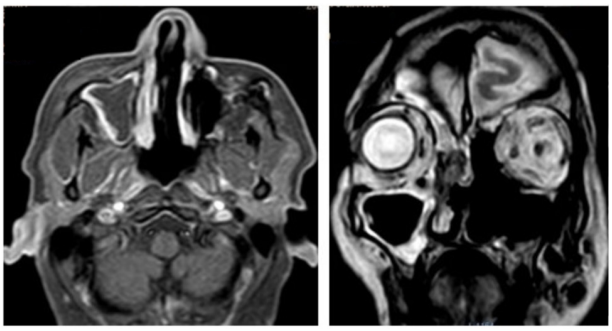
[14a] [14b]

A 49-year-old male received an MRI of the paranasal sinuses and orbits.

Figure 14) *Figures 14a and 14b: Sphenoidal sinus mucormycosis and extension to left temporal lobe with meningeal enhancement along the cortical surface, evidence of intracranial extension.*

Assessment of deep facial spaces and soft tissues

- Contrast-enhanced MRI also aided in the evaluation of deep facial compartments, particularly the infratemporal and pterygopalatine fossae (Figure 15).

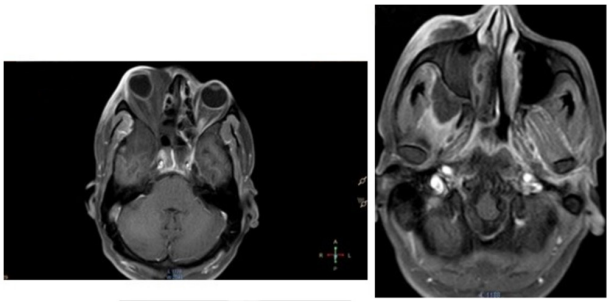


[15a] [15b]

A 56-year-old female had an MRI of the orbits and paranasal sinuses.

Figure 15) *Figures 15a and 15b: Sino-orbital mucormycosis involving right maxillary sinus and extensive cellulitis at right orbit. Focal collections at right infratemporal and pterygopalatine fossa.*

- Evidence of soft tissue edema, fluid collections and involvement of the cheek, nasolabial region and masticator space was particularly apparent in advanced cases (Figure 16).



[16a] [16b]

A 47-year-old male had MRI imaging of the orbits, paranasal sinuses and brain.

Figure 16) *Figures 16a and 16b: Orbital mucormycosis involving right orbit with retro-orbital inflammation and guitar pick sign. Focal collection at right infratemporal fossa with contiguous extension from right maxillary sinus.*

Discussion

The comparative study by Pranabananda Pal highlights a notable connection between sino-nasal infections and severe complications like orbital involvement, frontal lobe abscesses and cavernous sinus thrombosis [7]. These results align with those presented by Alka Agarwal ,who documented numerous cases illustrating various intracranial complications. Such research emphasizes the aggressive nature and swift advancement of fungal infections, especially in patients with weakened immune systems [8].

In our recent investigation, we found that most of the brain infarcts resulted from vasculitis, indicating an angioinvasive pathophysiology typical for mucormycosis. This finding is consistent with previous reports emphasizing vascular invasion as a key feature of disease progression. Rabia Arora further elaborates on this range of complications, highlighting clinical manifestations like orbital apex syndrome, cerebral infarctions, destruction of sinus walls, intruding infection into the orbit and filling defects in the cavernous sinus, all suggestive of thrombotic occurrences [9]. Correspondingly, our study identified 14 cases with orbital involvement, which exhibited infiltration through the lamina papyracea and the formation of focal collections along the medial orbital walls. Significantly, we observed involvement of the orbital apex in several instances, with direct infiltration of the optic nerve leading to permanent vision loss.

Moreover, in 10 patients, the infection had progressed into the infratemporal and pterygopalatine fossae, highlighting the invasive and extensive nature of the infection beyond the paranasal sinuses. Bone erosions affecting the skull base were also noted, particularly the destruction of the basi-sphenoid and the greater wing of the sphenoid in 5 cases. These findings underscore the possibility of life-threatening intracranial spread and the urgent need for early diagnosis.

Consistent with the management approaches proposed by Honavar, Santosh G our findings support the necessity for a structured, multidisciplinary protocol. Implementing a standardized care pathway, such as the code Mucor protocol, can facilitate swift diagnosis, radiologic assessment and surgical intervention, thereby greatly enhancing clinical outcomes [10].

Consistent with the management approaches proposed by Honavar, Santosh G. [10], our findings support the necessity for a structured, multidisciplinary protocol. Implementing a standardized care pathway, such as the Code Mucor protocol, can facilitate swift diagnosis, radiologic assessment and surgical intervention, thereby greatly enhancing clinical outcomes.

Conclusion

In summary, the use of sophisticated imaging techniques like Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) is crucial for the prompt identification and thorough evaluation of sino-nasal, orbital and intracranial mucormycosis. CT imaging is essential for recognizing initial bony erosions, sinus obstructions the degree of bone damage key indicators of invasive fungal infection. On the other hand, MRI excels in providing better soft tissue detail, allowing for accurate assessment of mucosal involvement, turbinate necrosis orbital spread, along with a vital examination of intracranial issues such as cavernous sinus thrombosis, meningeal enhancement and brain infarctions.

The development of rhino-cerebral mucormycosis is frequently swift, with aggressive infiltration of blood vessels and the central nervous system. Prompt recognition of inflammatory changes in the nasal cavity, maxillary and ethmoid sinuses and orbit especially when lesions are iso- or hypointense on T1 and T2-weighted images can greatly enhance diagnostic precision. Additionally, multiplanar MRI improves the visualization of anatomical limits, which is crucial for preoperative strategy and directing surgical procedures.

In spite of intensive antifungal treatments and extensive surgical debridement, the outlook for individuals with advanced rhino-cerebral mucormycosis continues to be cautious. Thus, early and precise imaging-based diagnosis is vital not only for enhancing survival rates but also for minimizing complications through focused and prompt intervention.

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